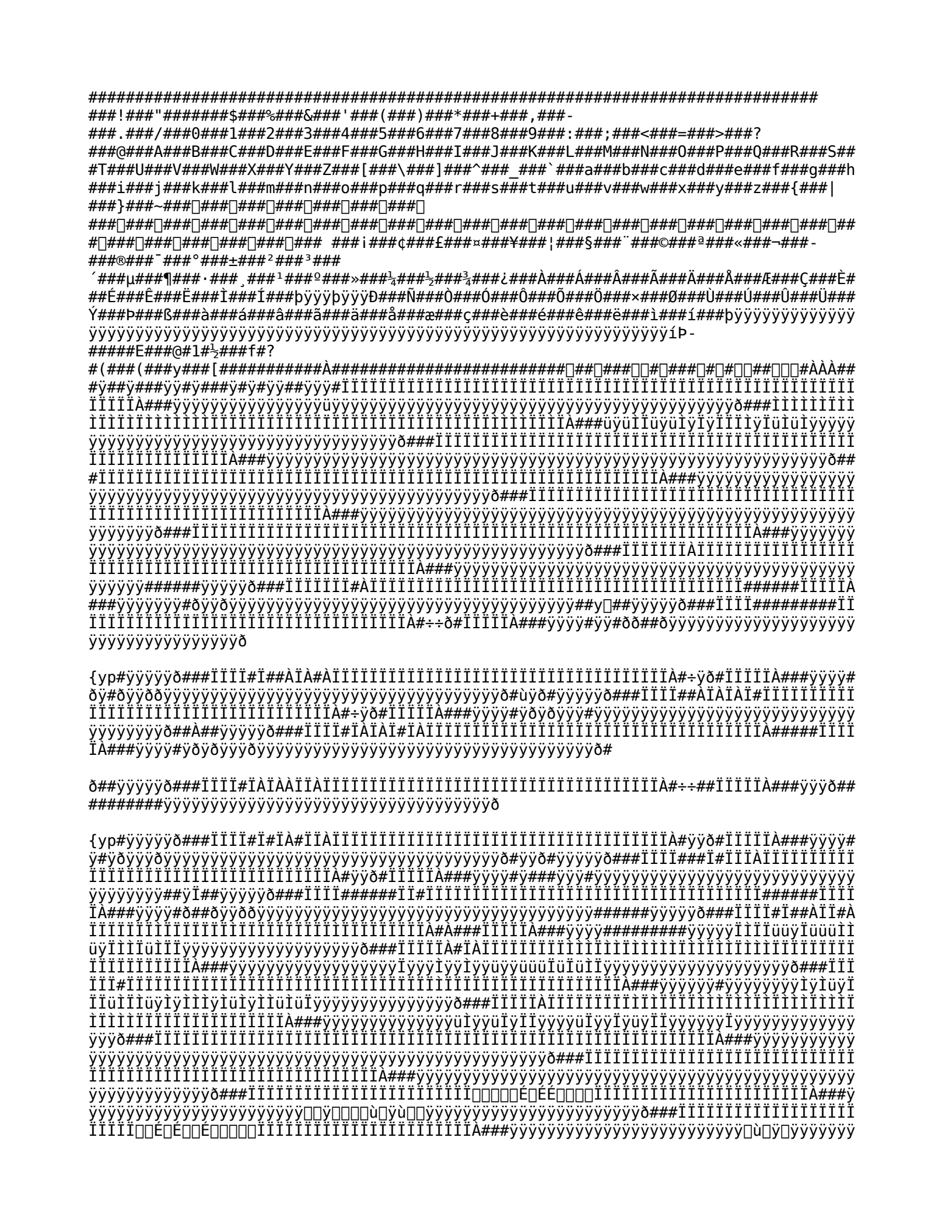

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##########ÿ□#ÿÿd#########Z#########□###1. Metrics are the key to a manager’s insight into a project. It is the mechanism by which managers can actually manage the project.2. DoD 5000.2 requires that we have metrics program but the instruction doesn’t say how, what, when - that’s for you to solve.3. In this module I will introduce you to the tools and resources you can use to start a metrics program on your project.#

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v#ÿÿ####ÿÿ#####ÿ□#ÿÿd#########X#########y###Learn what metrics are and why they are important to the success of a projectBecome familiar with the Practical Software Measurement Guide (PSM) and PSM ProcessUnderstand how to select and apply metrics on a projectBecome familiar with the SEI□s standard set of software metricsUnderstand the basic principles to be followed in implementing a successful metrics programe

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Úÿÿÿ####ÿÿ####Pÿ¥#ÿÿd#########Z#########*###Track actual progress against the schedule

###P#□#ÿÿd#########Z#########3##□##ï÷üù□#4 ûÿÿ####ÿÿ####Pÿ¥#ÿÿd#########Z#########Z###Intent: Provide visibility into actual progress #and oversight to enable corrective action

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##########ÿ□#ÿÿd#########Z#########±###1. A measurement is but a number, what is important is: a. The implication that are implied by the number. b. The number in the context of the collective set of numbers to be evaluated and/or interpreted. c. It is not in itself the answer but basis for asking why!2. Metrics can serve the manager in multiple contexts: a. Process - error removal rates, productivity rates b. Progress - traditional schedules, milestones c. Product - error density, CPs per 1k SLOC3. Hopefully we can expand the notion of metrics as servingmanagement, the sponsor, and the user.4. measurement = a number (e.g. 6ft.) metric = objective (e.g. height)#

##########ÿ#ÿÿd#########Z#########ø###- Break class into 3 teams and spend 5 minutes coming up with at least 3 reasons for collecting metricsProvide data points for realistic estimates/plansNeed historic data in order to calibrate cost estimating models. Cost estimating/planning are only as good as the data used as a basis.- Objectively defend and justify decisionsQuantifiable answers build confidence. Have the contractor include in the monthly status report his assessment as to the % complete of each End Product - a place to start.- Provide objective assessment of progress-Early detection and resolution of problems-Determine product qualityAllows us to define our standards for gating process transitions. For example, error density can be used to determine if the program is ready for moving from integrationtests to field tests.- Identify opportunities for process improvementAllows us to identify process activities that represent bottlenecks, targets for improvement.- Validate process improvementAllows us to validate that changes to our process have yielded the desired results. Did that new software tool increase productivity?- Reduce risk of customer dissatisfaction Reduces risk to the sponsor, the user, and most importantly yourself - a question of self preservation.

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###2##□##©ö□üW    v##############ÿ□#ÿÿd#########X##########¤###Produced by the Joint
Logistics Commanders Joint Group on Systems EngineeringPSM PrinciplesProgram
Issues and Objectives drive measurement requirementsDevelopers process determines
how the software is actually measuredCollect and analyze data at a level of detail
sufficient to identify and isolate software development process problemsPSM is a
PROCESS and is tied directly to a Project□s Risk Management Process
```

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#Rûÿÿ####ÿÿ#####ÿ##ÿÿd#########d#########%###Implement Measurement Program
Process#
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##############ÿ##ÿÿd#########d#########o###Identify and Prioritize Project Issues
Select and Specify Project MeasuresIntegrate into the Software Process#

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õ#ÿÿ####ÿÿ#####ÿ##ÿÿd#########d#########4###Issues, Objectives, Software Process Characteristics

##########ÿ□#ÿÿd#########X#(#######l###Explain each step of the □Implementing a Measurement Process□ process.Obtaining organizational support means that management is willing to commit resources to the metrics program.Defining measurement responsibilities means that someone is assigned to lead the metrics program, a metrics working group might be formed, a measurement analyst is appointed, etc...

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=#ÿÿ####ÿÿ#####ÿ□#ÿÿd#########X#########Î###Generate support for software measurement at all levels within the organization - briefings - training classes - involve stakeholders in developing measurement program Management-mandated measurement without organizational buy-in and multilevel support will seldom succeedAll levels of the organization need to understand how measurement will directly benefit their projects and their own work processes Gaining support usually requires cultural change

###ÿÿ#####ÿ¥#ÿÿd#########Y#(####### ###In order for a metrics program to succeed, support must be gained from the grass-roots level all the way to the top of the organization. Support can be generated through training, briefings, and by involving the stakeholders in developing the measurement program.l

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##ÿ¥#ÿÿd#########d#########□### Establishes high level performance objectives
Uses measurement results to make organizational and   enterprise level decisions

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Qÿÿÿ####ÿÿ#####ÿ¥#ÿÿd#########d#########\### Identifies and manages project
issues Uses measurement results to make program decisions

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L#ÿÿ####ÿÿ#####ÿ¥#ÿÿd#########d#########q###  Tailors measures to address program
issues  Collects and analyzes measurement data    and reports results#
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      ð#ÿÿ####ÿÿ#####ÿ¥#ÿÿd#########d#########a###  Uses measurement results    in
software engineering    efforts  Provides measurement   data#
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provide funding for measurement effort provide measurement tools□ Estimated Measurement Program Costs (Data Collection & Analysis)   - Estimated < 3% of project's total cost   - Cost of management usually estimated at   10-15% of the project's total cost   - Not an additional cost once management   starts using data to assist decisions□

Examples

Source	Data Collected	Cost (%)
NASA/SEL	Research	8 to 25
NEC(Japan)	Quality Factors	10-20
STC (UK)	Program Management	3 to 5
NUWC	Program Management	2 to 3
NASA/SEL	Program Management	2.5
STRICOM	Program Management	2
AT&T	Program Management	1.5
Motorola	Program Management	1

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###2##□##©ö□üW    v#ÿÿ####ÿÿ#####ÿ□#ÿÿd#########X#############Properly implemented
measurement becomes part of the way an organization does businessThe most
effective measurement process is one that is used and understood at all levels
within the organizationMeasurement must reflect existing software acquisition and
engineering capabilities#
```

###ÿÿ#####ÿ¥#ÿÿd#########X#(#######Ê###Measurement should be a part of an entire organizations▯ culture, not just for software. Measurement programs must be tailored to the individual organizations and projects. One size does not fit all.

###ÿÿ#####ÿ¥#ÿÿd#########X#(#######Y###This is just the first part of the PSM process. The second part will be discussed later.ÿ

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- Issues can be identified by performing a risk assessment (implement project risk management process and develop risk management plan) or by relying on past experiencePrioritize by ordering issues in terms of their expected impact and probability of risk occurring

###2##□##R÷ÑúB
□##############ÿ□#ÿÿd#########X#########i###Map issues to the 6 □common issues□ in the PSM   - Schedule and Progress - Resources and Cost   - Growth and Stability   - Product Quality - Development Performance   - Technical AdequacyMap to the common issues to measurement categoriesMap measurement categories into measuresSpecify data requirements   - determine level of detail of data to be collected#

###ÿÿ#####ÿ¥#ÿÿd#########X#(#######ñ###Explain that Risk Management is a big driver in the PSM process.Under □Specify data Requirements□, point out that the more granular the data, the more it costs to collect. You must weigh the benefit of the data vs. the cost to collect it.t

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###2##□##©öîû□ÿÖ#ÿÿ####ÿÿ#####ÿ□#ÿÿd#########X#############Schedule and Progress
Milestone PerformanceWork Unit ProgressIncremental Capability#Growth and Stability
Product Size and StabilityFunctional Size and Stability#Technical Adequacy
Technology ImpactsTarget Computer Resource UtilizationTechnical Performance
```

##ÿ##ÿÿd#########d#########r##□##j÷&ù÷#R ûÿÿ####ÿÿ#####ÿ□#ÿÿd#########X#########J###Software Issues - Categories - Measures Mapping#(excerpt from PSM Page 32)

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###############ÿ□#ÿÿd#########X#########ç###Resources and Cost   Personnel
Effort                                         Staff Experience
                 Staff Turnover                      Financial Performance   Earned
Value                                    Cost                    Environment
Availability     Resource Availability                                       Dates
                                   Resource Utilization#
```

###ÿÿ#####ÿ¥#ÿÿd#########X#(#######;###This is just one of the 6 issue categories from the PSM. #

##########ÿ#ÿÿd#########Z#########ã###This chart is here to make the point that not all metricsapply through out all phases of the acquisition.   Notonly must one reconsider metrics at each acquisitionactivity transition but also the frequency of data sampling.#

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=##############ÿ□#ÿÿd#########X#########L###Characterizing the software
environment - use developer□s current practices and existing data   #
collection mechanisms   - do not force process changes on the developerIdentifying
measurement opportunities   - potential candidates include all of the products
and processes   # used by the developer   - take advantage of any measurement
mechanisms already in place # (e.g. financial reports, defect counts, SLOC
counts)Specifying implementation requirements - describe how measurements will be
collected and reported# (can be documented in the SDP or a project measurement
plan)

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d#############ÿ□#ÿÿd#########X#########z###Issues and measures (list of issues)
Data elements (structures, attributes,and data items for all measures)Data
definitionsData sourcesLevel of measurement (level of detail of data collected)
Aggregation structure (structure by which data items will be combined)Frequency of
data collectionMethods of delivery (e.g. databases, electronic media)Communication
and interfaces (POC□s for data sources, reports)Frequency of analysis and
reportingWorking documentSample Measurement Plan included in the Software Project
Tracking and Oversight Process (http://sepo.spawar.navy.mil/docs.html#SOFTWARE
PROJECT TRACKING AND OVERSIGHT)

###ÿÿ#####ÿ¥#ÿÿd#########X#(#######Þ###The Project Measurement Plan does not need to be exhaustive. It should be used to provide some guidance for the project's metrics program. The plan will change frequently, especially in the beginning, so plan on change.

###ÿÿ#####ÿ¥#ÿÿd#########X#(#######X###This is the second half of the PSM process. Walk the students through each process step.

####ÿ□#ÿÿd#########X#########2##□##W÷[ù# ¼#ÿÿ####ÿÿ#####ÿ□#ÿÿd#########X#########-###Access dataData available from SDP, status reports, and engineering   databasesBaseline the planned and collect the actual data values (include all versions of the planning data; Plan 1,2,3,4,...) Collect data at least monthlyDevelop clear and concise definitions to guide data collection - know what the data meansCollect data at the appropriate level to localize problemsVerify DataQuestion unusual trends and inconsistenciesCheck for data ambiguities (numbers too large or too small)Does the data look too regular? Ensure the same units of measure (e.g. hrs, days, SLOC) are being used across all sourcesNormalize data (if applicable)Used when comparing or combining measurement data from different activities or from from software components with different characteristicsDo not expect perfect data#

###ÿÿ#####ÿ¥#ÿÿd#########X#(#######□###When comparing planned vs. actual, you need to compare actuals to all previous plans.Do not expect perfect data, some data will have □noise□ - this is normal.□Normalize Data□ is used when similar metrics are coming from 2 different sources (e.g. 2 subcontractors). Data should be normalized first before analyzing metrics to ensure that □apples vs. apples□ are being compared instead of □apples vs. oranges□.o

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      v#ÿÿ####ÿÿ#####ÿ□#ÿÿd#########X#########W###Indicator : A measure or combination of measures that provides insight into a software issue. Usually compares planned (baseline) versus actual values. Often displayed graphically. Basic indicators produced regularlyDecomposition of indicators to localize problemsNew indicators that respond to new questionsSets of related indicators#

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¾##############ÿ□#ÿÿd#########X#########U###Report ResultsThe measurement results must be clearly understood by the decision-maker, include all alternativesmeasurement should be used for communication and understanding, not punishment!Make results available throughout the organizationSelect Alternative Take actionAction must be taken to realize any benefit from measurement#

###ÿÿ#####ÿ¥#ÿÿd#########X#(#######I###It is important to report results throughout the organization, especially to the people who are collecting the data. In order to keep their interest in the metrics program, they need to know that their data is being used.Action must be taken as a result of the metrics program, otherwisecollecting metrics is a waste of time.#

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Actions may include: - Extend schedule to maintain quality - Add resources to stay on schedule - Delete capabilities to control costs - Change the process to improve performance - Reallocate resources to support key activities - Invoke Risk management contingency planUpdate software plans (SDP) to reflect actions takenEffects of actions should be tracked

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#7#ÿÿ####ÿÿ#####ÿ##ÿÿd#########d#########□### IssuesHave we □Planned□ for
sufficient resources?Are we □progressing□ asplanned?On budget? On schedule?How
good is the product?#
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Ã#############ÿ□#ÿÿd#########Z#########ä###Measure (Actual vs. Planned)
Function points, SLOC, CSCIs, SU□s, etc.Labor Costs, Labor Hours, etc.Actual vs. planned cost to date,Gantt Charts, Milestones, Reviews, Deliverables, etc.Defects, Changes, Fixes, etc.

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###□###Source: Carleton, et al., Software Management for DoD Systems:
Recommendations for Initial Implementation, SEI Technical Report,Sept 1992%
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□#Â#ÿÿ####ÿÿ#####ÿ##ÿÿd#########d#########¢###1.  Size, Effort, Cost, and Schedule
all relate to cost    estimating.  Metrics are the key data points needed to
calibrate our estimating tools who in turn are necessary    to establishing the
planning baselines against which we    track the actuals.2.  Quality - Developing
the □planned□ numbers can be    accomplished by comparative example or a tool
implementing    Halsteads error estimating algorithm.
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1. If you were to start with but one metric this would be a good choice.2. While the left vertical axis measure in absolute numbers the right vertical axis should be used to compare the number of outstanding trouble reports per 1KSLOC. In this manner we can see how we are closing in on what ever threshold of acceptance we have defined for the project.

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ÿd#########Z#########0###Cost and Schedule Metrics#(Earned Value example)
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This is an example of an earned value graph.1. This chart is communicating that by the 29th week 60% of the funds/work should have been completed; however, while 80% of the money has been expended only 40% of the work has been accomplished.2. The □cost variance□ represents the cost delta that will have to be added to our current spending rate (i.e., actual cost of work performed) in order to complete the program - a significant cost overrun from the original □planned cost of work scheduled□.3. The □schedule variance□ represents a theoretical catch up cost if we were spending at out originally planned rates.4. The key is to keep all the lines as close as possible, if not superimposed. At the first sign variance ask why and fix the cause.5. Tracking and graphing this information is easy using products such as Microsoft's Project Manager (MAC or PC), Computer Associate□s Super Project, or Macintosh□s equivalent.

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□#ÿÿ####ÿÿ#####ÿ□#ÿÿd#########d#########Æ###Work that spans more than 2 accounting months and cannot be broken down into similar unitsSelect milestones that represent justifiable divisions of work and weight them according to the amount of effort needed to complete the milestoneExample: Management Plan

Rough Draft	50% earned value
Review Complete	15% earned value
Comments Incorporated	20% earned value
Final Document Delivered	15% earned value
	100% earned value

###ÿÿ#####ÿ¥#ÿÿd#########X#(#######0###There are several methods that can be used to calculate earned value.Some of them are Interim Milestone Method, Apportioned Effort Method, Level of Effort Method, 50-50 Method, 0-100 Method, and the Equivalent Units Method.This should be an introduction to Earned Value and not an exhaustive tutorial.

###ÿ□#ÿÿd#########W#########1##□##èöoùÌ#@ #ÿÿ####ÿÿ#####ÿ##ÿÿd#########d#########Ç### Set clearly defined goals (Goal-Question-Metric (GQM) paradigm) Focus on project issues (risk management) Begin by only collecting a few key measurements Develop a □Project Measurement Plan□ Must have management commitment and □buy-in□ from project personnel - training, briefs - allocate adequate resources; metrics analyst - set up a metrics working group Provide timely feedback to project personnel on metrics analysis Automate measurement collection as much as possible - minimize impact on project personnel □ Measurement results should remain anonymous - do not measure individuals - all projects are different, do not compare - focus on the process and the product#

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1. Introducing a metrics program represents a culture shock -   Start small and allow time for the assimilation of a few   key metrics. Collection must become a habit. dont bury   the staff with so much that they loose site of program   goals and begin to believe that metrics are the goal.2. Starting slowly is critical in dealing with the contractor.   A good place to start is by integrating you data request   into the monthly status report.3. A word of caution. Metrics should not be used to evaluate   the performance of the individual staff members,   programmers, etc - it can lead to sensitivities that will   destroy the objectivity and value of the metrics program.4. Metrics are not a substitute for good management practices,   they are a tools to augment and enhance a managers ability   to make sound programmatic decisions.

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æ#ÿÿ####ÿÿ#####ÿ¥#ÿÿd#########X#########p###PSM Insight
(http://www.psmsc.com/insight.html)SPMN□s Software Project Control Panel
(http://www.spmn.com/pcpanel.html)MS ExcelMS AccessFileMakerProProject management
tools (e.g. MS Project)D87 Metrics ProceduresSEPO Weekly status reporting process
http://sepo.spawar.navy.mil/docs.html#SEPO INTERNAL PROCESSES AND PROCEDURES
NAVSSI status reporting procedures

###ÿÿ#####ÿ¥#ÿÿd#########X#(#######H###There are lots of metrics tools out there. Not too many “turn-key” systems though. You still have to figure out how to collect the data - that’s probably the hardest part. SEPO, NAVSSI, D87, and others at SSC SD have metrics programs. They can be a good place to start if you wand to start a metrics program on your project.

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ÿÿ####ÿÿ#####ÿ##ÿÿd#########d#############Lack of quantitative measures of project statusLack of project quality dataLack of ability to plan/estimate realisticallyDecisions based on hunches vs. factDelayed discovery of problemsLoss of potential process improvementsLoss of competitive positions

###ÿ□#ÿÿd#########X######!###2##□##©ö□üW
      v#ÿÿ####ÿÿ######ÿ□#ÿÿd#########X##########¦###Joint Logistics Commander□s
Practical Software Measurement (PSM) http://www.psmsc.comDepartment of the Army
Pamphlet 73-7, Section 10#http://www.army.mil/swmetrics/ddown.htmNASA Software
Measurement Guide Book (NASA-GB-001-94)#http://www.ivv.nasa.gov/SWG/resources/NASA
Software Measurement Guidebook (SEL-94-102)#http://fdd.gsfc.nasa.gov/selprods.html
Software Project Control Panel # http://www.spmn.com/pcpanel.html

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[#ÿÿ####ÿÿ#####ÿ##ÿÿd#########d############# Read the Joint Logistics Commander□s □Practical Software Measurement□ Select a few key metrics, start with simple ones Develop written organizational policy and procedures for collecting and data basing process, product, and project metrics.Establish responsibility for collecting and analyzing metrics data.Modify the contractors monthly status report to include end product completion percentage.Condition the staff to use weekly status reports focusing on work accomplishments.Acquire the tools (i.e., MS Project, MS Excel, PSM Insight, Software Project Control Panel) to support metric collection and reporting. Plan to review your program to add, or replace, metrics to continually improve your metrics process.#

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(Metrics)###################Brian and George##########################D###Hard
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